AP Calculus AB Cheat Sheet

AP Calculus AB Practice Test

Unit 1: Limits & Continuity

- Limit: The value (f(x)) approaches as x → c from both sides.
- One-sided limit: Value (f(x)) approaches as $x \to c^+$
- Simplifying limits: Use algebraic methods like rationalization, factoring, or completing the square.
- Growth rates: Fastest to slowest, for (f(x)/g(x)):
- If highest power of (f > g), the limit is infinite.
- If (f < g), horizontal asymptote at (y = 0).
- If powers are equal, horizontal asymptote at the ratio of the leading coefficients.
- Continuity types:
- Removable discontinuity (hole),
- Asymptote,
- Jump discontinuity (different (y)-values in a piecewise function).
- Intermediate Value Theorem (IVT): If (f(x)) is continuous on ([a, b]) and (f(c)) lies between (f(a)) and (f(b)), there is a (c) where (f(c) = f(c)).

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Unit 2: Differentiation: Definition and Fundamental Properties

- Definition of Differentiation
- Differentiation refers to the process of finding the derivative of a function. The derivative represents the rate of change of the function concerning its independent variable. In simple terms, it tells us how a function changes as the input changes.
- The derivative of a function f(x) at a point x=a is given by:
- $(f'(x) = \lim_{h \to 0} \frac{f(x+h) - f(x)}{h})$
- This formula calculates the slope of the tangent line to the curve at a specific point, providing an instantaneous rate of change.
- Derivative: Measures the rate of change of (f(x)) at a point.
- Power Rule: $(\frac{d}{dx} x^n = nx^{n-1})$
- Product Rule: $(\frac{d}{dx}[uv] = u'v + uv')$
- Quotient Rule: $(\frac{d}{dx}\left(\frac{u}{v}\right) = \frac{u'v - uv'}{v^2})$
- Chain Rule: Differentiate the outer function and multiply by the derivative of the inner function.
- Implicit Differentiation: Differentiate both sides with respect to (x) and multiply by dydxdydx when differentiating (y).
- Inverse Functions: Derivatives of inverse trig functions can be found by using cofunctions.

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Unit 3: Differentiation of Composite, Implicit, and Inverse Functions

- **Composite Functions:** Differentiation of composite functions is handled using the chain rule. The chain rule states that you differentiate the outer function and multiply it by the derivative of the inner function.

$$(\frac{d}{dx}[f(g(x))] = f'(g(x)) \cdot g'(x))$$

- **Implicit Differentiation:** Used when functions are not given explicitly as y=f(x). Differentiate both sides of the equation with respect to x, and apply $(\frac{dy}{dx})$ whenever differentiating y. $(\frac{d}{dx}[xy] = y + x\frac{dy}{dx})$
- **Inverse Functions:** To differentiate inverse functions, use the following rule:

$$(\frac{d}{dx}[f^{-1}(x)] = \frac{1}{f'(f^{-1}(x))})$$

- The derivatives of inverse trigonometric functions are also important. For example:

$$(\frac{d}{dx}\arcsin(x) = \frac{1}{\sqrt{1-x^2}})$$

- Differentiation plays a key role in all these methods, as it involves finding rates of change for more complex relationships between variables.

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Unit 4: Contextual Applications of Differentiation

- Related rates:
- Draw a diagram.
- Write down knowns/unknowns.
- Form an equation (don't substitute changing values yet).
- **Linearization:** Approximate the value of a function using the tangent line.
- **L'Hopital's Rule:** Apply only when the limit yields indeterminate forms (like (0/0)).
- **Mean Value Theorem (MVT):** If (f(x)) is continuous and differentiable, there's a (c
- Where $(f'(c) = \frac{f(b) - f(a)}{b - a})$
- Rolle's Theorem: Special case of MVT where (f(a) = f(b)).

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Unit 5: Analytical Applications of Differentiation

- **Critical Points:** Where (f'(x) = 0) or undefined.
- **Local Extrema:** Occurs at critical points or endpoints; use first or second derivative tests to determine if it's a max or min.
- **Inflection Points:** Where (f''(x) = 0) and concavity changes.
- Optimization:
- Draw a picture.
- Write primary equation.
- Substitute constraints and solve for variables.

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Unit 6: Integration of Accumulation of Change

- **Definite Integral:** Represents the area under the curve of a rate of change function.
- **Riemann Sums:** Approximate the area under the curve by summing the areas of rectangles (Left Riemann, Right Riemann, Midpoint).
- Fundamental Theorem of Calculus:
- **Part 1:** The integral of (f'(x)) over ([a, b]) equals (f(b) - f(a)).
- **Part 2:** If (F'(x) = f(x)), then (\int f(x) dx = F(b) - F(a)).
- **U-Substitution:** A method for simplifying integrals, especially useful for composite functions.

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Unit 7: Differential Equations

- **Separation of Variables:** Rewrite the differential equation in the form $(\frac{dy}{dx})$, and solve by integrating both sides.
- **Slope Fields:** Graphical representation showing tangents to the solution curves.
- **Exponential Growth/Decay:** $y = Ce^{kx}$ where C is the initial value and k is the growth/decay rate.

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Unit 8: Applications of Integration

- Average Value of a Function: $(\frac{1}{b-a}\int_a^b f(x)\,dx)$
- Area between Curves: The integral of (f(x) - g(x)), where (f(x)) is the upper curve and (g(x)) is the lower curve.
- Disk/Washer Method: Used for finding volumes of solids of revolution. For washers, subtract the inner radius from the outer radius.

Additional Notes: